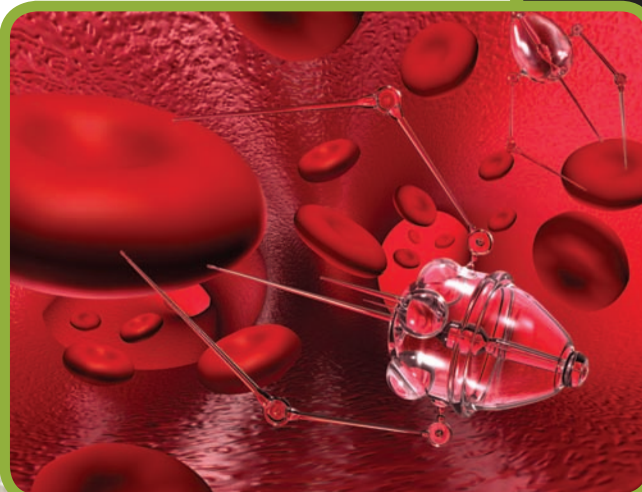
FOCUSING on the INVISIBLE

by Tim R. Haley

You can't see it, but soon it will be everywhere. The size of one nano is a billionth of a meter. Nanotechnology is the science of building microscopic devices at the molecular and subatomic levels. These invisible tools are destined to be used in a vast number of industries and fields of engineering and science.

In the medical field, nanotechnology will be used to help with diagnosing and treating diseases. For instance, tiny gold-coated "nanoshells" could act like smart bombs, zeroing in on a tumor, entering cancer cells, and lying in wait until an infrared beam or radio wave signals the particles to release an intense, deadly dose of heat energy that destroys the cancer cells.



DOES THE DESIGN AND DEVELOPMENT OF AN EDUCATIONAL LABORATORY REALLY CHANGE WHEN THE FOCUS OF THE TEACHING IS INVISIBLE–THE NANO WORLD?

THE NSABP PATHOLOGY LABORATORY PHOTO IS COURTESY OF THE NSABP FOUNDATION, INC.

This is all well beyond my understanding, given the biology laboratory of my youth, where I used mice, worms, toads, and other unsuspecting creatures to learn the structure of a living organism. The overlying question is how do we teach this new technology, and where? Will we use the same educational laboratory facility that has existed for years at every school, college, or university?

Does the design and development of an educational laboratory really change when the focus of the teaching is invisible—the nano world? Even the word nanotechnology is as radical as one can believe, and to imagine a structure that facilitates the teaching of such science generates thoughts of a fundamentally different nature when it comes to design.

However, today the dominion of educational laboratory design is being explored and changed, not only to facilitate the extreme of the nano world, but to increase flexibility for collaborative initiatives of the "real world" and crossdisciplinary engagements, all driven by the new technologies.

In the article, "Trends in Lab Designs" published in *Whole Building Design Guide*, the authors stated, "Science functions best when it is supported by architecture that facilitates both structured and informal interaction, flexible use of space, and sharing of resources" (Watch & Tolat, 2007). They further noted that, "modern science is an intensely social activity. The most productive and successful scientists are intimately familiar with both the substance and style of each other's work. They display an astonishing capacity to adopt new research approaches and tools as quickly as they become available. Thus, science functions best when it is supported by architecture that facilitates both structured and informal interaction, flexible use of space, and sharing of resources."

A collaborative laboratory, according to the article, requires:

- Creating flexible engineering systems and casework that encourage research teams to alter their spaces to meet their needs
- Designing offices and write-up areas as places where people can work in teams
- Creating "research centers" that are team-based
    - Creating all the space necessary for research team members to operate properly in proximity to one another
    - Minimizing or eliminating spaces that are identified with a particular department
- Establishing clearly defined circulation patterns
- Providing interior glazing to allow people to see one another.

Are collaborative, interactive, and multidisciplinary spaces and buildings the only changes necessary to facilitate the teaching of new technologies? If this is the case, perhaps the renovation of all current laboratories requires essentially gutting what we have and creating a large shell that can be used to place movable fixtures, served overhead by utilities that are on large grids allowing for maximum flexibility, and not enclosing the space or creating any subspace.

However, it is not that simple. The invisible nano requires sophisticated viewing equipment, environmentally dustfree, vibration resistant, RF (Radio Frequency), and EMI (Electromagnetic Interference) controlled to degrees unheard of only a decade ago. An open, interactive space may be an area for discussion and interdisciplinary partnerships, but the actual nano laboratory is a tightly controlled space. Today's trend is new space, as opposed to renovating space. High-bay laboratories– with flexible and movable fixtures–are a must, such as in the Molecular Science and Engineering Building at Georgia Tech. Designed by CUH2A, it is a multi-disciplined building offering a variety of spaces including nanobiotech and nanochemistry.

Another example can be found at the University of Arizona, where the Meinel Optical Sciences Research Lab is a physical sciences facility designed by Architects Richärd+ Bauer. It contains 47,000 square feet, including a multitude of labs allowing research in total darkness or at extremely low levels of light. In every lab, overhead flex grids with connections for power, data, and lasers bring the necessary energy and technology to the microscopy systems. The building contains Class 10,000 clean-rooms with a small amount of Class 100 space, absolutely necessary for today's nanotechnology.

There are great examples of laboratories specifically built for nanotechnology, such as the National Standards and Technology Laboratory, designed by HDR Architects. This facility is specifically designed to:

"… spy an individual molecule in a throng of millions, to seize it, and to manipulate it…To arrange atoms into an ordered nanotechnology landscape of precisely spaced steps and terraces … To determine the size of an electrical current by tabulating, one by one, the number of electrons flowing by…To gauge distances in increments tinier than the radius of an atom… To measure the strength of a chemical bond between an antibody and a virus particle."

The facility was completed in 2004 and, at the time, had few equals among the top research facilities. Is the nanotechnology laboratory the "lab of the future" or is it merely a "now thing?" There are other new discoveries that are currently developing; how will they affect our institutional facility design? Will the "lab-on-a-chip" or MEMS—the integration of biochemical analysis with microelectromechanical systems—change current design parameters? Or will the needs for robotics and automation in the laboratory change the need for more energy, more space, and different space? And what if virtualreality laboratories at several institutions, such as the University of New York, UCLA, the University of Connecticut, or the Swiss Federal Institute of Technology, were to be merged with the current state-of-the-art nanotechnology, and we were able to teach using less space with fewer restrictions on air quality and the cleanliness of the space?

The website for the Building Science Laboratory at the University of California, Berkeley (*http://arch.ced.berkeley.edu/resources/bldgsci/bsl/bsl.html*) states, "The quality of our built environment depends on the ability of designers to judge, in advance, how their designs will perform when constructed. For individual designers, this judgment comes from training and experience, but the knowledge underlying their judgment often originates from research."

The nano may be invisible, but the impact of this new technology and its future subdivisions are currently stimulating the design of the laboratory of the future.

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